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United States
Department of
Agriculture

Forest
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Forest
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Dividends From Wood Research

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Explanation and Instructions

"Dividends From Wood Research" is a semiannual listing of recent publications resulting from wood utilization research at the Forest Products Laboratory (FPL). These publications are produced to encourage and facilitate application of Forest Service research. This issue lists publications received from the printer between January 1 and June 30, 1994.

Each publication listed in this brochure is available through at least one of the following sources.

Available from FPL (indicated by an order number before the title of the publication): Quantities limited. Circle the order number on the blank at the end of the brochure and mail or FAX the blank to FPL.

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Available through libraries: Research publications are available through many public and university libraries in the United States and elsewhere. U.S. Government publications are also available through many Government Depository Libraries. Check with a major library near you to determine availability.

List of Categories

Publications are listed in this brochure within the following general categories:

- Anatomy and Identification
- Biodeterioration and Protection
- Energy
- Engineering Properties and Design Criteria
- Fiber and Particle Products
- Fire Safety
- General
- Microbial and Biochemical Technology
- Mycology
- Processing of Wood Products
- Pulp, Paper, and Packaging
- Timber Requirements and Economics
- Wood Bonding Systems

Recent Publications

January–June 1994

Anatomy and Identification

1. Morphology and Anatomy of the Malagasy Genus *Physena* (*Physenaceae*), With a Discussion of the Relationships of the Genus

Dickison, W.C.; Miller, R.B.
1993. Bull. Mus. natl. Hist. nat., Paris, 4^e sér., 15, section B, Adansonia, n°s 1–4 : 85–106.

The vegetative and reproductive morphology and anatomy of the puzzling Malagasy dicotyledonous genus *Physena* were studied in an attempt to determine its affinities. Detailed descriptions of leaf, axis, nodal, wood, floral, pollen, and fruit morphology and anatomy are provided.

2. Identification of Wood Fragments in Trace Evidence

Miller, Regis B.
1994. In: Proceedings of the international symposium on the forensic aspects of trace evidence; 1993 June 24–28; Quantico, VA. Quantico, VA: U.S. Department of Justice Federal Bureau of Investigation: 91–11.

This paper describes the techniques used at the USDA Forest Service, Forest Products Laboratory, to handle and identify different sizes of wood fragments. Examples of actual cases are also presented.

Biodeterioration and Protection

Basidiosporogenesis by White-Rot Basidiomycete *in vitro*

Croan, Suki C.
1994. Prepared for 25th annual meeting of the International Research Group on Wood Preservation; 1994 May 29–June 3; Bali, Indonesia. Document IRG/WP 94–10081.

Available from IRG Secretariat, Box 5607, S- 114 86 Stockholm, Sweden. Cost: 150 Swedish crowns.

The objective of this study was to demonstrate *in vitro* methods that promote carpogenesis and basidiosporogenesis by the white-rot basidiomycetes, *Schizophyllum commune* and *Trametes versicolor*.

Effect of Thickened Boron in Preventing Conidial Germination of Sapwood-Inhabiting Fungi

Croan, Suki C.
1994. Prepared for 25th annual meeting of the International Research Group on Wood Preservation; 1994 May 29–June 3; Bali, Indonesia. Document IRG/WP 94–30059.

Available from IRG Secretariat, Box 5607, S- 114 86 Stockholm, Sweden. Cost: 150 Swedish crowns.

The objective of this study was to evaluate the effectiveness of the thickened boron formulation, Diffusol, for protecting wood in field trials (adverse exposures, frequent rain and humidity). This study reports on the inhibition of conidial germination of mold and sapstain fungi by the thickened boron formulation, DIFFUSOL.

Nondestructive Assessment of Biodegradation in Southern Pine Sapwood Exposed to Attack by Natural Populations of Decay Fungi and Subterranean Termites

De Groot, Rodney C.; Ross, Robert J.; Nelson, William
1994. Prepared for 25th annual meeting of the International Research Group on Wood Preservation; 1994 May 29–June 3; Bali, Indonesia. Document IRG/WP 94–20042.

Available from IRG Secretariat, Box 5607, S- 114 86 Stockholm, Sweden. Cost: 150 Swedish crowns.

This study tested Southern Pine sapwood stakes that were vertically inserted for half their length in soil in a forest in southern Mississippi. The results showed that measurement of both speed and attenuation of a reciprocating impact-induced wave will yield quantitative information on extent of total biodegradation in Southern Pine sapwood, independent of organism causing the damage.

3. Probing the Wood-Paint Puzzle

Feist, William C.; Williams, R. Sam.
1993. Am. Paint Coat. J. Conven. Daily. 78(21): 33–34.

This paper discusses the future and continuing need for research and support in (1) performance of organic solvent and cosolvent-compliant wood finishes, (2) acquiring basic information on how weathering interactions affect the performance of wood and wood panel products used for outdoor siding, (3) determining the importance of surface roughness and back priming on finish performance, (4) developing new methods of treating wood surfaces for stability toward water, sunlight, micro-organisms, and other causes of degradation, and (5) finishing and restoring heavily weathered wood and the refinishing of finished wood.

Hemicellulosic Induction of Oxalic Acid in *Postia placenta*

Green, Frederick III; Larsen, Michael J.; Highley, Terry L.
1994. Prepared for 25th annual meeting of the International Research Group on Wood Preservation; 1994 May 29–June 3; Bali, Indonesia. Document IRG/WP 94–10060.

Available from IRG Secretariat, Box 5607, S- 114 86 Stockholm, Sweden. Cost: 150 Swedish crowns.

A previous study dealt with the hydrolysis of hemicellulose under acid treatment of Southern Pine with either hydrochloric or oxalic acid. This mirrors the reported rate of acid hydrolytic susceptibility of hemicellulose being 1,500 times greater than cellulose. This study extends these findings by determining the amount of oxalic acid produced *in vitro* to a variety of polymeric carbohydrates.

4. Movement and Persistence of Basamid in Wrapped Douglas-fir and Southern Pine Timber

Highley, Terry L.
1993. Mater. Org. 28(1): 75–78.

The purpose of this study was to determine fumigant efficacy in wrapped, nonpressure-treated Douglas-fir and Southern Pine timbers treated with Basamid.

Effect of *Scytalidium lignicola* on Decay Resistance and Strength of Wood

Highley, Terry L.
1994. Prepared for 25th annual meeting of the International Research Group on Wood Preservation; 1994 May 29–June 3; Bali, Indonesia. Document IRG/WP 94–10061.

Available from IRG Secretariat, Box 5607, S- 114 86 Stockholm, Sweden. Cost: 150 Swedish crowns.

This study determined the (1) ability of *S. lignicola* to colonize and survive in wood exposed in the field, (2) decay resistance of blocks removed from previously treated *S. lignicola* wood, and (3) effect of *S. lignicola* on strength of wood (modulus of rupture).

5. Research on Biodeterioration of Wood, 1987–1992.

I. Decay Mechanisms and Biocontrol

Highley, Terry L.; Clausen, Carol A.; Croan, Suki C.; Green, Frederick III; Illman, Barbara L.; Micales, Jessie A.
1994. USDA Forest Serv. Res. Pap. FPL-RP-529. 20 p.

This research paper first describes current knowledge about how white- and brown-rot fungi decay wood and then delineates research in two problem areas: (1) control of wood decay through targeting biosynthetic and degradative pathways and (2) biological control (biocontrol) of wood decay through nondecay micro-organisms. Finally, directions for further research are described in the areas of biology of wood deterioration and protection of wood without chemical pesticides.

Borate Diffusion From Fused Borate Rods in Douglas-fir Transmission Poles

Highley, Terry L.; Finney, W.; Green, F. III
1994. Prepared for 25th annual meeting of the International Research Group on Wood Preservation; 1994 May 29–June 3; Bali, Indonesia. Document IRG/WP 94–30042.

Available from IRG Secretariat, Box 5607, S- 114 86 Stockholm, Sweden. Cost: 150 Swedish crowns.

This paper reports the distribution of boron from fused borate rods installed in Douglas-fir transmission poles in 1992 made on behalf of a government facility near Chicago, Illinois.

6. Research on Biodeterioration of Wood, 1987–1992.

II. Diagnosis of Decay and In-Place Treatments

Highley, Terry L.; Micales, Jessie A.; Illman, Barbara L.; Green, Frederick III; Croan, Suki C.; Clausen, Carol A.
1994. USDA Forest Serv. Res. Pap. FPL-RP-530. 7 p.

The purpose of the research described in this report is to improve the performance of wood by protecting it against fungi that discolor or decay the wood during processing or in service, primarily above ground. To accomplish this objective, methods for diagnosing fungal attack in the early stages and simple preventive and remedial means for controlling both stain and decay fungi were developed.

Oxalic Acid Quantification, Oxaloacetase Assay and ESI Localization of P, C, and Fe From the Brown-Rot Fungus *Postia placenta*

Jordan, Candace R.; Dashek, William V.; Highley, Terry L.
1994. Prepared for 25th annual meeting of the International Research Group on Wood Preservation; 1994 May 29–June 3; Bali, Indonesia. Document IRG/WP 94–10063.

Available from IRG Secretariat, Box 5607, S- 114 86 Stockholm, Sweden. Cost: 150 Swedish crowns.

This paper reports the results of a combined biochemical and electron systems imaging investigation designed to test the hypothesis that brown-rot-induced wood decay involves an oxaloacetase, oxalic acid, H_2O_2/Fe^{++} Fenton-type mechanism.

Siderophore Production by *Trichoderma* spp. and its Importance in the Biological Control of Wood Decay Fungi

Srinivasan, Usha; Bruce, Alan; Highley, Terry L.
1994. Prepared for 25th annual meeting of the International Research

Group on Wood Preservation; 1994 May 29–June 3; Bali, Indonesia. Document IRG/WP 94.

Available from IRG Secretariat, Box 5607, S- 114 86 Stockholm, Sweden. Cost: 150 Swedish crowns.

This study examined the potential role of *Trichoderma* siderophores in the biocontrol of wood decay fungi.

Energy

7. Projected Wood Energy Impact on U.S. Forest Wood Resources

Skog, Kenneth E.

1993. In: Proceedings of 1st biomass conference of the Americas: Energy, environment, agriculture, and industry; 1993 August 30–September 02; Burlington, VT. Golden, CO: National Renewable Energy Laboratory: 18–31. Vol. 1.

The USDA Forest Service has developed long-term projections of wood energy use as part of a 1993 assessment of demand for and supply of resources from forest and range lands in the United States. To assess the impact of wood energy demand on timber resources, a market equilibrium model based on linear programming was developed to project residential, industrial, commercial, and utility wood energy use from various wood energy sources: roundwood from various land sources, primary wood products mill residue, other wood residue, and black liquor.

8. Reduction of Atmospheric Carbon Emissions Through Displacement of Fossil Fuels

Zerbe, John I.

1993. World Resource Review. 5(4): 414–423.

This paper is a preliminary look at the magnitude of carbon sequestration in wood products in the United States and the opportunities for reducing fossil fuel consumption and conserving energy through wood utilization.

Engineering Properties and Design Criteria

Proceedings, American Society of Agricultural Engineers (ASAE) International Winter Meeting, December 14–17, 1993, Chicago, IL.

Available from Order Department, American Society of Agricultural Engineers, 2950 Niles Road, St. Joseph, MI 49085–9659.

Member: \$5.50 per copy plus \$3.50 shipping and handling; nonmember: \$7.00 per copy plus \$3.50 shipping and handling.

Expanded Stochastic Model for Localized Lumber Properties by Taylor, S.E.; Hernandez, R.; Boatwright, H.T. Paper 934536.

The objectives of this paper were to (1) characterize localized modulus of elasticity, tension, and specific gravity for several grades and sizes of southern pine and yellow poplar lumber and (2) expand a multivariate model to simulate the localized lumber properties modulus of elasticity, tension, and specific gravity.

Portable Timber Bridge Designs for Low Volume Forest Roads by Taylor, S.E.; Ritter, M.A.; Murphy, G.L.; Thompson, J.D. Keliher, K.P. Paper 937511.

New designs of timber bridges are cost-effective alternatives for portable stream crossing structures. Bridge design criteria and performance of a portable, longitudinal glued-laminated deck timber bridge are discussed in this paper.

Building Products From Recycled Wood Waste

Falk, Robert H.

1994. In: Resource efficiency for the nineties: Proceedings of the 12th annual international energy efficient building conference and exposition; 1994 February 23–26; Dallas, TX. Wausau, WI: Energy Efficient Building Association. E1–E7.

Available from Energy Efficient Building Association (EEBA), Northcentral Technical College, 1000 W. Campus Dr., Wausau, WI 54401–1899. Member: \$35.00 each plus \$4.75 shipping and handling per each copy; nonmember: \$45.00 each plus \$4.75 shipping and handling per copy. Must purchase complete proceedings—EEBA does not furnish single copies of articles.

This paper describes the ongoing technology efforts at the USDA Forest Service, Forest Products Laboratory, that focus on the development of building products from recycled wood waste. Promising technologies, including dry-formed processing, wet-formed processing, and wood/plastic and wood/cement composite manufacture, are discussed. Performance evaluation and standards development, which are necessary to move recycled building products into widespread use, are also covered.

9. Mechanical Properties of Red Maple Structural Lumber

Green, David W.; McDonald, Kent A.

1993. Wood Fiber Sci. 25(4): 365–374.

Efficient utilization of hardwood structural lumber depends on developing better procedures of grading and property assignment. This study evaluated the properties of red maple 2- by 4-in. (standard 38- by 89-mm) lumber tested in bending and in tension and compression parallel to the grain and compared the results to published values derived by ASTM D 245 clear wood procedures.

10. Probabilistic Modeling of Yellow Poplar Glued-Laminated Timber

Hernandez, Roland.

1993. Paper 93–4534. Paper presented at 1993 International winter meeting of the American Society of Agricultural Engineers; 1993 December 14–17; Chicago. St. Joseph, MI: American Society of Agricultural Engineers: 11 p.

The overall objective of this study was to simulate the performance of yellow poplar glulam timber using Monte Carlo simulation procedures. Specific objectives of this study were to analyze the results of lumber tests conducted to characterize input properties and compare actual and simulated yellow poplar glulam beam performance.

11. Reaction Rate Model for the Fatigue Strength of Wood

Liu, Jen Y.; Zahn, John J.; Schaffer, Erwin L.

1994. Wood Fiber Sci. 26(1): 3–10.

In this paper, the fatigue strength of wood structural members is considered. That is, a mathematical model for time-dependent strength under sinusoidal load is developed.

12. Red Maple Stress-Graded 2 by 4 Dimension Lumber From Factory-Grade Logs

McDonald, Kent A.; Green, David W.; Dwyer, Jack; Whipple, James W.

1993. Forest Prod. J. 43(11/12): 13–18.

The objectives of this study were to determine the nominal 2- by 4-in. (38- by 89-mm) stress-grade dimension lumber yields from graded red maple logs by scaling diameter classes and to compare those yields to the expected factory lumber yields reported for logs of the same size and quality.

13. LRFD for Engineered Wood Structures—Connection Behavioral Equations

McLain, Thomas E.; Soltis, Lawrence A.; Pollock, David G., Jr.; Wilkinson, Thomas L. 1993. *J. Struct. Eng.* 119(10): 3024–3038.

This study describes the new behavioral equations, the results of calibration to existing practice, and identifies potential changes in connection design that may be seen when comparing load and resistance fact or design and allowable stress design.

14. Expanded Markets for Engineered Wood Products: The Forest Products Laboratory's View

Peterson, K.R.; Falk, R.H.; Wolfe, R.; McNatt, J.D.; Hernandez, R. 1993. In: Bender, Donald A., ed. *Wood products for engineered structures: issues affecting growth and acceptance of engineered wood products*. Proceedings 47329. 1992 November 11–13; Las Vegas. Madison, WI: Forest Products Society: 164–166.

Many wood products available for construction today are quite different than those traditionally used for wood construction. Builders have at their disposal many new wood products such as prefabricated wood I-joists, structural composite lumber, and oriented strandboard. By the year 2000, projections suggest that a total of 1.53×10^9 lineal feet (4.71×10^8 m) of these new engineered wood products will be produced in the United States. This paper presents the Forest Products Laboratory's view of the market for these new engineered wood products and speculations on the opportunities and requirements necessary to capture this market share of growth.

15. Experimental Shear Strength of Glued-Laminated Beams

Rammer, Douglas R.; Soltis, Lawrence A. 1994. USDA Forest Serv. Res. Pap. FPL-RP-527. 38 p.

The objective of this study was to improve current shear design criteria by (1) establishing a test method to determine beam shear, (2) establishing a database for beam shear strength and correlating it to shear block test results, (3) determining if there is a correlation between shear and bending strength, and (4) determining if there is a correlation between shear strength and beam size.

16. Shear Strength of Unchecked Glued-Laminated Beams

Soltis, Lawrence A.; Rammer, Douglas R. 1994. *Forest Prod. J.* 44(1): 51–57.

The allowable stress in shear is derived from shear tests of small clear shear blocks, but the shear strength of shear blocks is much greater than the shear strength of larger beams. In this study, glued-laminated beams were tested to determine shear strength. These specimens were tested in five-point bending test configuration.

17. Ventilation, Humidity, and Condensation in Manufactured Houses During Winter

TenWolde, A. 1994. *ASHRAE Transactions*. Vol. 100, Part 1, 13 p.

The first objective of this study was to obtain additional information on the moisture behavior of manufactured houses as well as additional data on moisture release from occupants and other sources. The second objective was to expand on reported results by evaluating the effect of mechanical ventilation on humidity and comfort, condensation, and energy consumption during winter.

18. Modeling Four-Layer Nail-Laminated Assemblies

Williams, G.D.; Bohnhoff, D.R.; Moody, R.C. 1993. Paper 93-4534. Paper presented at 1993 International winter meeting of the American Society of Agricultural Engineers; 1993 December 14–17; Chicago. St. Joseph, MI: American Society of Agricultural Engineers: 22 p.

The objectives of this study were to use finite element analysis to determine how changes in splice arrangement, overall splice length, joint spacing, and butt-joint reinforcement affect bending strength and stiffness of four-layer nail-laminated assemblies.

19. Bending Properties of Four-Layer Nail-Laminated Posts

Williams, G.D.; Bohnhoff, D.R.; Moody, R.C. 1994. USDA Forest Serv. Res. Pap. FPL-RP-528. 16 p.

The objectives of this study were to determine how the bending strength and stiffness of unsPLICED four-layer nail-laminated posts are related to strength and stiffness of single members, how splicing affects the strength and stiffness of four-layer nail-laminated posts, and how splice length, splice arrangement, and outside butt-joint reinforcement affect post strength and stiffness.

20. Contemporary Issues Facing Nail Fasteners

Wills, B.L.; Bender, D.A.; Winistorfer, S.G. 1993. Paper 93-4545. Paper presented at 1993 International winter meeting of the American Society of Agricultural Engineers; 1993 December 14–17; Chicago. St. Joseph, MI: American Society of Agricultural Engineers: 19 p.

This paper focuses on problems facing manufacturers, designers, and users of nail fasteners and recommends approaches for solving these problems. Threaded nail fasteners are emphasized because of their extensive use in agricultural structures, together with the fact that relatively little performance data are available for these types of fasteners.

Material Selection and Preservative Treatments for Outdoor Wood Structures

Winandy, Jerrold E.; McDonald, Kent A. 1993. *Wood Design Focus*. 4(3): 8–13.

Available from Forest Products Society, 2801 Marshall Court, Madison, WI 53705. Cost: \$2 each, with \$5 minimum, plus 10 percent postage and handling.

The long-term performance of wood in exterior exposure depends on material quality and decay resistance, either natural or that imposed by chemical treatment. The information presented here is intended to aid those who design and construct wood decks or similar outdoor structures.

21. Dynamic Load Effect on the Lateral Strength of Nails for the Manufactured/Modular Housing Industry

Winistorfer, Steve G.; Soltis, Lawrence A. 1993. In: Bender, Donald A., ed. *Wood products for engineered structures: issues affecting growth and acceptance of engineered wood products*. Proceedings 47329. 1992 November 11–13; Las Vegas. Madison, WI: Forest Products Society: 199–204.

In this study, 240 joints were tested to investigate the effects of several variables: hand-driven, uncoated nails compared to power-driven, adhesive-coated nails; low- and high-humidity environments; particleboard and gypsum board filler material; and level of dynamic frequency.

22. Longitudinal Shrinkage in Fast-Grown Loblolly Pine Plantation Wood

Ying, Lu; Kretschmann, David E.; Bendtsen, B. Alan. 1994. *Forest Prod. J.* 44(1): 58–62.

In this study, longitudinal shrinkage was investigated, and derived equations that will assist in determining the age at which the transition to mature material were completed for loblolly pine (*Pinus taeda* L.). A predictive equation for longitudinal shrinkage based on age was also determined.

Fiber and Particle Products

23. Environmentally Induced Physical Changes in Ancient Kauri (*Agathis Australis*) Wood

Freedland, Cassia; Rowell, Roger M.; Plackett, David
1994. *Wood Fiber Sci.* 26(1): 51–61.

To explore the interaction of the chemical and physical changes in wood over time, 30,000-year-old and recently felled kauri wood (*Agathis australis*) from New Zealand was used in this study as test specimens. Using recently felled kauri as a basis for comparison, changes in the chemical composition of the ancient kauri were characterized through extensive chemical analyses. Through static bending tests and spectroscopic studies of cut and fractured cell surfaces, the interaction of chemical change and structural alteration over time could be elucidated.

24. Fixation of Compressed Wood Using Melamine-Formaldehyde Resin

Inoue, Masafumi; Ogata, Shigeyuki; Kawai, Shuichi; Rowell, Roger M.; Norimoto, Misato.
1993. *Wood Fiber Sci.* 25(4): 404–410.

The study reported here investigated the ability of a low molecular weight, water-soluble melamine-formaldehyde resin system to permanently fix compressed specimens and increase hardness.

25. Concepts for Fiber-Based Structural Building Systems

Laufenberg, Theodore L.
1993. In: *Proceedings of the International Panel and Engineered Wood Technology Exposition*; 1993 October 19–21; Atlanta, GA. Atlanta, GA: PETE. 10 p.

This paper discusses the avenues for growth in fiber-based composite materials as follows: (1) Processing innovations and efficiencies leading to reduced cost or improved performance using fiber-based products made with agricultural, virgin, or recycled wood, paper, and synthetic fibers, (2) market supplementation for solid-sawn lumber products, (3) innovative designs of components and systems based on the engineered properties of the composites, and (4) interdisciplinary education and training of technologists, engineers, scientists, and wood users.

26. Enhancements to Performance: Wood Composites

Laufenberg, Theodore L.
1993. In: Bender, Donald A., ed. *Wood products for engineered structures: issues affecting growth and acceptance of engineered wood products*. Proceedings 47329. 1992 November 11–13; Las Vegas. Madison, WI: Forest Products Society: 47–56.

This paper presents the potential for use of wood composites in structural markets from the technological viewpoint. Technological limitations of existing composite processes and products are reviewed in the context of the present laminated veneer lumber, parallel strand lumber, flakeboard, and fiber/paper industries. The limits of mechanical property potential are presented to show that strength and stiffness may be enhanced through innovative processing of structural wood composites.

27. The Bending Stiffnesses of Corrugated Board

Luo, S.; Suhling, J.C.; Considine, J.M.; Laufenberg, T.L.
1992. In: Perkins, R.W., ed.. *Mechanics of cellulose materials*. New York: The American Society of Mechanical Engineers. 15–26.
AMD Vol. 145/MD-Vol. 36.

In this study, an analytical study on the bending stiffnesses of corrugated board was performed. Formulations to calculate the bending stiffnesses D_{11} , D_{22} , D_{12} , and D_{66} of the equivalent plate representing the corrugated board was established and then

compared to expressions suggested by other investigators. Several methods for modeling the shape of the corrugated orthotropic medium material were considered, including sinusoidal, arc-and-tangent, and elliptical representations. An extension of the membrane analogy method was used to calculate the torsional rigidity D_{66} of the corrugated board.

28. Swelling of Wood—Part 1. Swelling in Water

Mantanis, G.I.; Young, R.A.; Rowell, R.M.
1994. *Wood Sci. Technol.* 28: 119–134.

In this study, the rate and maximum swelling of several North American wood species in water were obtained with a computer interfaced linear variable displacement transformer. Because wood swells extremely fast in water even at room temperature, this apparatus made it possible for the first time to obtain accurate rate data on the swelling of wood in water.

29. A Characteristics Model Approach to Demand Analysis for Wood Composites

Marcin, Thomas C.
1993. In: *Forest sector, trade and environmental impact models: theory and application: Proceedings of an international symposium*; 1992 April 30–May 01; Seattle, WA. Seattle, WA: CINTRAFOR: 119–124.

This report presents a conceptual framework for analyzing the demand for composite wood products based upon the Lancaster model of consumer demand. The Lancaster approach is opposed to traditional demand theory in that the characteristics or attributes of goods are demanded by the consumers, not the goods per se.

30. Stability of Acetylated Wood to Environmental Changes

Rowell, Roger M.; Lichtenberg, Rebecca S.; Larsson, Pia.
1993. *Wood Fiber Sci.* 25(4): 359–364.

The purpose of this study was compare acetylated wood to varying pH, moisture, and temperature conditions and determine loss of acetyl. These data can be used to predict the expected life of an acetylated product under different use conditions.

31. Reinforcing Polypropylene With Natural Fibers

Sanadi, Anand R.; Caulfield, Daniel F.; Rowell, Roger M.
1994. *Plastics Engineering*. L(4). 2 p.

In this study, the properties of a 50-weight % kenaf-polypropylene composite are compared with those of systems commonly used in the plastics industry. Kenaf was chosen for this study because it is a crop grown commercially in the United States. In this work, the fibers were not chemically liberated from the filaments, as the pulping procedure can consume significant energy.

32. Recycled Newspaper Fibers as Reinforcing Fillers in Thermoplastics: Part I—Analysis of Tensile and Impact Properties in Polypropylene

Sanadi, A.R.; Young, R.A.; Clemons, C.; Rowell, R.M.
1994. *J. Reinf. Plastics Comp.* 13: 54–67.

Recycled newspaper fibers are potentially outstanding nonabrasive reinforcing fibers with high specific properties. In this study, a high energy thermokinetic mixer was used to mix these fibers in a polypropylene matrix, and the blends were then injection molded to observe the tensile and impact strength levels of the composites.

33. Edgewise Crush Test Streamlined by Shorter Time After Waxing

Urbanik, Thomas J.; Catlin, Arthur H.; Friedman, Davide R.; Lund, Richard C.
1994. *Tappi J.* 77(1): 83–86.

The objective of this study was to measure the strength effects of reconditioning time after waxing using various grades of corrugated fiberboard and conditioned short-column specimens. This report summarizes the results of the interlaboratory study.

34. Stabilization of Acoustical Properties of Wooden Musical Instruments by Acetylation

Yano, Hiroyuki; Norimoto, Misato; Rowell, Roger M.
1993. *Wood Fiber Sci.* 25(4): 395–403.

The purpose of this research was to determine the effects of acetylation on (1) changes in E/g and Q⁻¹; (2) stabilization of acoustic properties of wood using a free-free vibrational beam test and an all-sides-clamped plate test; and (3) reduction of drops in tuned frequency caused by deformation of wooden parts under stress, using a full-scale model of the string-sustaining part of a piano pin block.

35. Agricultural Fibers in Composition Panels

Youngquist, J.A.; English, B.E.; Spelter, H.; Chow, P.
1993. In: Maloney, Thomas M., ed. *Proceedings of the 27th international particleboard/composite materials symposium*; 1993 March 30–31; April 1; Pullman, WA. Pullman, WA: Washington State University: 133–152.

This paper addresses options for using agricultural materials alone or in combination with wood to produce composition panel products. Past research and technology available on a regional basis throughout the world are reviewed first. Agricultural fiber options for North America are discussed, and a brief review of performance properties that can be obtained using these fibers is provided.

Fire Safety

36. Modeling the Burner Source Used in the ASTM Room Fire Test

Tran, Hao C.; Janssens, Marc L.
1993. *J. Fire Prot. Engr.* 5(2): 53–66.

Modeling fire growth over wall linings in a compartment requires experimental data and a model of the fire source. This paper reports data obtained from steady-state experiments of gas burner flames. The reported data are restricted to the vertical part of the corner flames and plumes below turn at ceiling.

37. Enhancements to Performance: Design for Fire Resistance

White, Robert H.
1993. In: Bender, Donald A., ed. *Wood products for engineered structures: issues affecting growth and acceptance of engineered wood products*. Proceedings 47329. 1992 November 11–13; Las Vegas. Madison, WI: Forest Products Society: 63–67.

The structural integrity of new engineered wood products in a fire will be critical for their acceptance in the 21st century. This paper gives examples of past and current research and the available design tools to improve the fire-resistance performance of engineered wood products.

General

38. Forest Products Research—Not Just Wood As Usual

Dietzman, Debra
1993. *J. Forestry*. 91(11): 13–15.

The USDA Forest Service, Forest Products Laboratory, has seen meeting the technological challenges of wood users for more than

80 years. However, Forest Products Laboratory research could not be accomplished without an extensive network of cooperators among interested association, business, and academic partners. To meet the many challenges ahead, assistance is needed from all sectors and a large variety of disciplines. Forest products research and the Forest Products Laboratory will continue to aid the forests of today and tomorrow.

Microbial and Biochemical Technology

39. Field Evaluation of the Lignin-Degrading Fungus *Phanerochaete sordida* to Treat Creosote-Contaminated Soil

Davis, Mark W.; Glaser, John A.; Evans, James W.;

Lamar, Richard T.

1993. *Environ. Sci. Technol.* 27(12): 2572–2576.

A field study to determine the ability of selected lignin-degrading fungi to remediate soil contaminated with creosote was performed at a wood-treating facility in south central Mississippi in the autumn of 1991. The effects of solid-phase bioremediation with *Phanerochaete sordida* and of two control treatments on soil concentrations of 14 priority pollutant polycyclic aromatic hydrocarbon components of creosote were followed for 56 days.

40. Biodegradation of Lignin and Hemicelluloses

Jeffries, Thomas W.

1994. In: Ratledge, C., ed. *Biochem. Microbial Degradation*: 233–277.

The focus of this paper is on specialized or recently revealed aspects of the structural mechanisms of wood hemicelluloses and lignins.

41. Biosynthetic Pathway for Veratryl Alcohol in the Ligninolytic Fungus *Phanerochaete chrysosporium*

Jensen, Kenneth A., Jr.; Evans, Kathryn M.C.; Kirk, T. Kent; Hammel, Kenneth E.

1994. *Appl. Environ. Microbiol.* 60(2): 709–714.

Veratryl alcohol (VA) is a secondary metabolite of white-rot fungi that produce the ligninolytic enzyme lignin peroxidase. VA stabilizes lignin peroxidase, promotes the ability of this enzyme to oxidize a variety of physiological substrates, and is accordingly thought to play a significant role in fungal ligninolysis. Pulse-labeling and isotope-trapping experiments have now clarified the pathway for VA biosynthesis in the white-rot basidiomycete *Phanerochaete chrysosporium*.

42. Solid-Phase Treatment of a Pentachlorophenol-Contaminated Soil Using Lignin-Degrading Fungi

Lamar, Richard T.; Evans, James W.; Glaser, John A.

1993. *Environ. Sci. Technol.* 27(12): 2566–2571.

The abilities of three lignin-degrading fungi—*Phanerochaete chrysosporium*, *Phanerochaete sordida*, and *Trametes hirsuta*—to deplete pentachlorophenol (PCP) from soil contaminated with PCP and creosote were evaluated.

43. Manganese Peroxidases of the White Rot Fungus *Phanerochaete sordida*

Ruttmann-Johnson, Carmen; Cullen, Daniel; Lamar, Richard T.
1994. *Appl. Environ. Microbiol.* 60(2): 599–605.

In this study, the ligninolytic enzymes produced by the white-rot fungus *Phanerochaete sordida* in liquid culture were studied.

Mycology

44. Serological Differentiation of Two Forms of *Phellinus Weiri*

Burk, Mark T.; Paul, Jennifer A.; Burdsall, Harold H., Jr.; Cook, Mark E.
1993. Mycologia. 85(4): 605–611.

Two forms of *Phellinus weiri* exist in North America that are morphologically similar, and identification of these isolates is often difficult. The purposes of this study were (1) to assess the potential of using an enzyme-linked immunosorbent assay (ELISA) as a rapid means of separating these two forms in culture and (2) to determine the relatedness of the two forms and *P. sulphurascens* from Asia using ELISA and Western blots from polyacrylamide gel electrophoresis.

45. The State of Taxonomy of the Genus *Armillaria*

Burdsall, Harold H., Jr.; Volk, Thomas J.
1993. McIlvainea. 11(1): 4–12.

The genus *Armillaria* has been the bane of mycologists ever since its establishment by Fries as a tribe of *Agaricus*, a genus to which he ascribed nearly every gilled fungus, regardless of spore color, nutritional situation, or other characteristics we use in taxonomy today. This paper concentrates on the taxonomy of *Armillaria* in the Northern Hemisphere. Most comments also apply to the Southern Hemisphere.

46. Preserving Cultures of Wood-Decaying Basidiomycotina Using Sterile Distilled Water in Cryovials

Burdsall, Harold H., Jr.; Dorworth, Elizabeth B.
1994. Mycologia. 86(2): 275–280.

Prior to 1985, cultures at the Center for Forest Mycology Research at the USDA Forest Service, Forest Products Laboratory, were maintained on 1.5% malt extract agar test-tube slants. This system not only made it necessary to transfer the entire collection every year but also permitted genetic change because continual growth occurred. In 1985, the method of storing fungal cultures in sterile distilled water in cryovials was introduced. This study reports on the use of this method for long-term fungal storage.

47. Separation of Protoplasts From Mycelial Fragments With a Simple-Filtration Device

Darmono, T.W.; Burdsall, H.H., Jr.
1993. Biotech. Techniques. 7(11): 805–808.

This paper describes a simple filtration device developed to obtain pure protoplasts. Pure protoplasts, free of mycelial fragments, are required for biological manipulation of protoplasts. The filtration device can also be used to separate fungal conidia, isolated nuclei, or DNA from mycelial fragments for further purification and manipulation.

48. *Phellinus sulphurascens* and the Closely Related *P. weiri* in North America

Larsen, Michael J.; Lombard, Francis [Frances] L.
1994. Mycologia. 86(1): 121–130.

The purpose of this communication is to further clarify the taxonomic and nomenclatural position of the two forms of *Phellinus weiri* in North America and confirm the unifactorial mating systems previously demonstrated.

49. Biosystematic Studies on *Phlebia Acerina*, *P. Rufa*, and *P. Radiata* in North America

Nakasone, Karen K.; Sytsma, Kenneth J.
1993. Mycologia. 85(6): 996–1016.

This report describes three closely related taxa: *Phlebia radiata* Fr., *P. rufa* (Pers.; Fr.) M. P. Chris., and *P. acerina* Peck. Because of the extensive variation in the basidioma and hymenial configuration, these species are sometimes difficult to distinguish. *Phlebia radiata* and *P. rufa* are well-known taxa that differ in basidiospore shape and size.

Processing of Wood Products

50. Saw Blade Heating and Vibration Behavior in a Circular Gang Edger

Danielson, Jeanne D.; Schajer, Gary S.
1993. In: Szymani, Ryszard, ed. Proceedings of Saw Tech '93—3d International conference on sawing technology; 1993 October 14–16; San Francisco, CA. Berkeley, CA: Wood Machining Institute: 117–136.

This study was conducted to observe the thermal and vibration behavior of thin kerf saws in a guided splined arbor edger operating under sawmill production conditions and to relate this behavior to sawing variation. Starting from the base case of good sawmill practice, three factors that can adversely affect saw performance were considered: saw blade overtensioning, saw heating as a result of inadequate guide cooling, and guide movement during sawing.

51. Localized Modulus-of-Elasticity Properties of E-Rated Spruce-Pine Laminating Lumber

Govindarajoo, Renganathan; Pellerin, Roy F.; Ross, Robert J.
1993. Forest Prod. J. 44(4): 25–32.

One requirement in the development of stochastic models of glued-laminated timber beams is that adequate consideration be given to the variation of localized modulus of elasticity within the laminations. A second-order Markov model could be used to generate this variation. This study presents the data necessary to describe the Markov model for a sample of 2.0 E, 1.7 E, and 1.4 E grades of nominal 2- by 6-in. (38- by 140-mm) E-rated spruce-pine laminating lumber.

52. Detection of Northern Red Oak Wetwood by Fast Heating and Ion Mobility Spectrometric Analysis

Petersen, Roger C.; Ward, James C.; Lawrence, André H.
1993. Holzforschung. 47(6): 513–522.

When a tree becomes infected with bacteria and subsequently wetwood, there is often no outward sign that this condition exists. Lumber from the tree may also appear normal, but when the green wood is kiln dried, it usually develops checks, ring failure, or honeycomb, and large economic losses result. Therefore, developing a rapid and reliable method to detect wetwood in tree stems before they are processed into lumber is important. Such a method is presently not available on an industrial scale, but efforts are underway to achieve this goal. The method developed in this investigation is based on techniques of trace vapor detection originated at the National Research Council. This technique involves a rapid two-step procedure: the thermal release of vapors from wood samples (heating) followed by analysis using ion mobility spectrometry. Results are obtained in a matter of seconds.

53. Nondestructive Testing for In-Place Assessment of Wood Members

Ross, Robert J.; Pellerin, Roy F.
1993. In: Bender, Donald A., ed. Wood products for engineered structures: issues affecting growth and acceptance of engineered wood products. Proceedings 47329. 1992 November 11–13; Las Vegas, NV: Forest Products Society: 176–179.

During the past 30 years, forest products researchers and the forest products industry have developed and used nondestructive testing

(NDT) tools for a wide range of applications—from the grading of structural lumber to the in-place evaluation of the mechanical properties of individual members in wood structures. The USDA Forest Service, Forest Products Laboratory, recently published a report that reviews NDT techniques used with wood products. This paper provides a synopsis of that report.

54. Non-Destructive Evaluation of Timber in the United States

Ross, R.J.; Pellerin, R.F.; Sato, M.

1994. In: Negataki, S.; Nireki, T.; Tomosawa, F., eds. Durability of building materials and components. Vol. 2—Durability, repair, design: Proceedings of 6th International conference; 1993 October 26–29; Omiya, Japan. New York: E & FN Spon: 1229–1235.

Nondestructive evaluation of materials, the science of identifying the physical and mechanical properties of materials without altering their end-use capabilities, is valuable in defining relationships between properties and performance of materials. This paper provides a synopsis of a comprehensive report that reviews nondestructive testing of wood research and application techniques.

55. Nondestructive Testing for Assessing Wood Members in Structures—A Review

Ross, Robert J.; Pellerin, Roy F.

1994. USDA Forest Serv. Gen. Tech. Rep. FPL-GTR-70. 40 p.

Numerous organizations have conducted research to develop nondestructive testing (NDT) techniques for assessing the condition of wood members in structures. A review of this research was published in 1991. This is an update of the 1991 report. It presents a comprehensive review of published research on the development and use of NDT tools for in-place assessment of wood members.

56. Acetyl Distribution in Acetylated Whole Wood and Reactivity of Isolated Wood Cell-Wall Components to Acetic Anhydride

Rowell, Roger M.; Simonson, Rune; Hess, Sabine; Plackett, David V.; Cronshaw, Dave; Dunningham, Elizabeth.

1994. Wood Fiber Sci. 26(1): 11–18.

The objectives of the research described in this paper were to determine (1) the reactivity of isolated cell-wall components from pine wood to acetic anhydride and (2) the distribution of acetyl groups in cell-wall polymers of acetylated whole pine wood at different levels of bonded acetyl weight gains. It is expected that these data will aid in the understanding of the mechanism of biological resistance of wood based on chemical modification.

57. Resistance Moisture Meter Correction Factors for Four Tropical Wood Species

Simpson, William T.

1994. USDA Forest Serv. Res. Note FPL-RN-0260. 6 p.

In this paper, correction factors were determined for an electrical resistance-type moisture meter for African celtis (*Celtis* sp.), dahoma (*Piptadeniastrum africanum*), ramon (*Brosimum alicastrum*), and danto (*Vatairea lundellii*). For all species, correction factors were negative for most of the moisture content range, meaning that the meter readings were generally greater than the true moisture content.

58. Resistance Moisture Meter Correction Factor for Pacific Yew

Simpson, William T.; Loehnertz, Stephen P.

1994. Forest Prod. J. 44(1): 63–64.

The objective of this study was to develop the species correction factor for Pacific yew for an electrical resistance-type moisture meter.

59. Short, Clear Specimens for Estimating Drying Time of Sugar Maple Lumber

Simpson, William T.; Tschermitz, John L.; Sarfo, James S. 1994. Wood Fiber Sci. 26(2): 171–177.

In this study, the drying times of full-length, sugar maple sapwood boards were compared to those of matched, short boards at eight temperature, relative humidity, and air velocity combinations. The objective was to determine if short specimens dry in the same time as full-length specimens.

60. A Numerical Model for Heat Transfer and Moisture Evaporation Processes in Hot-Press Drying—An Integral Approach

Tang, Yifu; Pearson, Ronald G.; Hart, C. Arthur; Simpson, William T.

1994. Wood Fiber Sci. 26(1): 78–90.

A numerical model, which was based on the energy principle that the rate of water evaporation from the interface (or wet line) at a given time during hot-press drying was controlled by the rate of heat energy reaching the interface at that time, has been developed. The model treats the drying as a process in which the retreat of the interface and free water flow to the interface occur simultaneously.

Pulp, Paper, and Packaging

61. USDA Forest Products Laboratory Pulp and Paper Pilot Plant and Recycling Activities

Abubakr, Said; Klungness, John H.; Gaumnitz, Lisa

1994. Progress in Paper Recycling. 3(2): 17–23.

Concern over the amount of paper and wood waste being dumped annually into the nation's landfills is fueling a drive to recycle and reuse these materials. Spurred by the twin desires to save on landfill space and more efficiently use the country's natural resources, Americans are collecting paper for recycling at an ever-increasing rate. But, limited markets for these recovered materials, stemming in part from technical and economic barriers to recycling, prevent recovered paper from being recycled at the same rate that it's being recovered. Research at the Forest Products Laboratory seeks to remove these barriers; the Laboratory is helping to develop technology to divert more than a quarter of additional materials from landfills by the year 2000. Staff researchers will be collaborating with university and industry scientists on a number of projects that include developing new contaminant removal processes and developing new environmentally safe pulping and bleaching technologies.

62. Raman Spectroscopic Evidence for Coniferyl Alcohol Structures in Bleached and Sulfonated Mechanical Pulps

Agarwal, Umesh P.; Atalla, Rajai H.

1993. In: Heitner, Cyril; Sciaiano, J.C., eds. Photochemistry of lignocellulosic materials. ACS symposium series 531. Proceedings of 203d national meeting of the American Chemical Society; 1992 April 5–10; San Francisco. Washington, DC: American Chemical Society: 26–44.

The purpose of this work was to investigate the nature of lignin in bleached mechanical pulp and sulfonated chemithermomechanical pulp (CTMP). Specifically, the purpose was to identify structures that may be responsible for photoyellowing.

63. Raman Spectroscopy

Atalla, R.H.; Agarwal, U.P.; Bond, J.S.

1992. In: Lin, Stephen Y.; Dence, Carlton, W., eds. Methods in lignin chemistry. New York: Springer-Verlag: 162–176.

This is a chapter from *Methods in Lignin Chemistry* that discusses the application of Raman spectroscopy in relation to lignin analytical chemistry. The article includes a comparison to infrared spectroscopy.

64. Ester Crosslinking to Improve Wet Performance of Paper Using Multifunctional Carboxylic Acids, Butanetetracarboxylic and Citric Acid

Caulfield, Daniel F.
1994. *Tappi J.* 77(3): 205–212.

Butanetetracarboxylic acid and citric acid are two multifunctional carboxylic acids that have potential for use in formaldehyde-free durable press finishing of fabrics. In this study, these acids were investigated as cellulose crosslinking agents for modifying the wet performance of paperboard.

65. Compressive Creep Behavior of Corrugating Components Affected by Humid Environment

Considine, John M.; Stoker, Denise L.; Laufenberg, Theodore L.; Evans, James W.
1994. *Tappi J.* 77(1): 87–95.

This study provides the preliminary work for the development of a test method or procedure that will evaluate the behavior of corrugated containers in varying moisture environments.

66. Spaceboard II Structural Panels: Forming Apparatus and Methods

Gunderson, Dennis F.; Gleisner, Roland L.
1994. *Wood Fiber Sci.* 26(1): 19–27.

In the study reported here, thick spaceboard panels were made using the porous mandrel method. The report describes the forming apparatus and fabrication process.

67. Apparatus for Evaluating Stability of Corrugated Board Under Load in Cyclic Humidity Environment

Gunderson, D.E.; Laufenberg, T.L.
1994. *Experimental Techniques.* 18(1): 27–31.

This report describes a useful testing apparatus for measuring the deformation of large numbers of specimens using a single linear variable. The application of this equipment requires long term monitoring of specimens subjected to load and cyclic relative humidity conditions. This equipment is instrumental in demonstrating the affect of cyclic moisture on the creep properties of corrugated board when loaded in edgewise compression and flat-wise bending.

68. Influence of Hydrodynamic Environment on Composition and Macromolecular Organization of Structural Polysaccharides in *Egregia menziesii* Cell Walls

Hackney, J.M.; Kraemer, G.P.; Atalla, R.H.; VanderHart, D.L.; Chapman, D.J.
1994. *Planta.* 192: 461–472.

The purpose of this study was to investigate whether adaptive responses by marine brown algae to hydrodynamic variables may be detected within secondary and tertiary structures of cellulose and associated insoluble polysaccharides in cell walls. Such changes develop in terrestrial-plant celluloses in response to mechanical stress.

69. Economic Projections of Recovered Paper Supply in the United States

Howard, James L.; Ince, Peter J.; Bickelhaupt, Jill
1993. *In: Forest sector, trade and environmental impact models: theory and applications: Proceedings of an international*

symposium; 1992 April 30–May 01; Seattle, WA. Seattle, WA: CINTRAFOR: 226–229.

The use of recovered paper is related to timber supply and demand as well as the feasibility of expanded recycling programs. The objective of this study was to develop recovered paper supply functions for the four principal grades of recovered paper.

70. Pulpwood and Timber Trends: Outlook to 2000 and Beyond

Ince, Peter J.
1993. *In: 1993 Pulping conference proceedings; 1993 November 1–3; Atlanta, GA. Atlanta, GA: TAPPI Press: 381–389. Book 1.*

This paper summarizes an economic assessment of future trends in pulp and paper technology and future impacts on timber markets in North America. Projections extend five decades into the future, to the year 2040. Two recently developed scenarios are discussed, a 1993 Base scenario and a Waste Reduction scenario.

71. North American Pulp and Paper Model: Market Trends, Technological Changes and Impacts of Accelerated Paper Recycling

Ince, Peter J.; Roberts, Don G.; Jacques, Romain
1993. *In: Forest sector, trade and environmental impact models: theory and applications: Proceedings of an international symposium; 1992 April 30–May 02; Seattle, WA. Seattle, WA: CINTRAFOR: 33–38.*

The North American Pulp and Paper Model (NAPAP Model) is a recent modeling development. The model is designed to project the evolution of markets and technology of the pulp and paper sector in the United States and Canada. This paper introduces the model structure, with a general description of methods, function of the model, and projections of accelerated paper recycling.

72. Comparison of Enzyme-Enhanced With Conventional Deinking of Xerographic and Laser-Printed Paper

Jeffries, Thomas W.; Klungness, John H.; Sykes, Marguerite S.; Rutledge-Cropsey, Kathie R.
1994. *Tappi J.* 77(4): 173–179.

This study examines seven commercial enzymes with cellulase activity, xylanase activity, or a combination of both applied to paper stock in the pulper at optimum conditions for each enzyme.

Emerging Technologies for Reuse of Lignocellulosic Materials—Recycling Our Disposed Wood and Paper

Laufenberg, Theodore L.
1994. *MRS Bulletin.* 19(2): 13–14.

Available from Materials Research Society, 9800 McKnight Road, Pittsburgh, PA 15237. Cost: \$16.

This article provides a glimpse of some of the challenges in using recovered lignocellulosics in the paper and chemical industries. The article describes efforts to define this emerging class of materials and the expected impact these definitions will have on the producing and consuming industry and public.

73. Hornification—Its Origin and Meaning

Minor, James L.
1994. *Progress in Paper Recycling.* 3(2): 93–95.

Hornification is a technical term in the recycling literature that refers to the physical change that takes place in a papermaking fiber upon drying. The term is currently not in common nontechnical use, but it does have a long and interesting history. Its introduction to the papermaking literature is attributed to G. Jayme in 1944. The manifestations of hornification in recycling and some methods of preventing or reversing it are briefly discussed in this paper.

74. Crystallinity in the Polypropylene/Cellulose System. I. Nucleation and Crystalline Morphology

Quillin, Daniel T.; Caulfield, Daniel F.; Koutsky, James A. 1993. *J. Appl. Poly. Sci.* 50: 1187–1194.

The purpose of this study was to investigate the effect of various chemical surface treatments on the nucleation ability of cellulose in polypropylene, using optical microscopy and differential scanning calorimetry.

75. Bleaching Kraft Pulps With Peroxymonosulfate and Oxygen

Springer, Edward L.; McSweeney, James D. 1993. In: *Proceedings of 1993 Pulping conference*; 1993 November 1–3; Atlanta, GA. Atlanta, GA: TAPPI Press: 453–457. Book 2.

A new bleaching sequence has been developed for bleaching softwood and hardwood kraft pulps, using no chlorine or chlorine-containing chemicals. The treatment sequence consists of an acid pretreatment, acidic peroxymonosulfate, oxygen delignification, and alkaline peroxymonosulfate brightening. In this study, the sequence was evaluated using pine and aspen kraft pulps. Brightness levels in the mid-eighties were achieved. Because no chlorine-containing chemicals are used, spent liquors from bleaching may be sent to chemical recovery.

76. Environmental Compatibility of Effluents of Aspen Biomechanical Pulps

Sykes, Marguerite. 1994. *Tappi J.* 77(1): 160–166.

Biopulping, the fungal treatment of wood chips prior to mechanical refining, is an experimental pulping method that conserves energy and produces paper with enhanced physical properties. This study examines the toxicity and biochemical oxygen demand of effluents from pulps incubated with either *Phanerochaete chrysosporium* or *Ceriporiopsis subvermispora*, two of the most effective fungi screened for use in biopulping.

77. Use of the Term “Bleaching” in the Context of Virgin and Secondary Fibers: A Clarification

Weinstock, Ira A. 1993. *Progress in Paper Recycling*. 3(1): 89–91.

In its broadest sense, bleaching is defined as the removal of color. However, in papermaking and recycling, the term has more than one meaning, each associated with the treatments required to produce white pulps suitable for papermaking. The purpose of this article is to clarify terminology related to the bleaching of recycled (secondary) fibers.

78. FT Raman and UV Visible Spectroscopic Studies of a Highly Selective Polyoxometalate Bleaching System

Weinstock, Ira A.; Minor, J.L.; Reiner, Richard S.; Agarwal, Umesh P.; Atalla, Rajai H.

1993. In: *Proceedings of 1993 Pulping conference*; 1993 November 1–3; Atlanta, GA. Atlanta, GA: TAPPI Press: 519–532. Book 2.

Near-Infrared Fourier Transform Raman spectroscopy and ultraviolet visible spectroscopy were used to observe chemical changes in residual lignin in softwood kraft pulp upon exposure to a vanadium-substituted polyoxometalate. This is representative of a new class of bleaching agents currently under investigation.

Timber Requirements and Economics

79. Demographic Change—Implications for Forest Management

Marcin, Thomas C. 1993. *J. Forestry*. 91(11): 39–45.

This paper discusses the major demographic changes occurring in the United States and worldwide that will profoundly affect the demand for forest products and the uses of forests. These trends also influence how society views forest management and forest policy.

Wood Bonding Systems

80. Behavior of Amine-Modified Urea-Formaldehyde-Bonded Wood Joints at Low Formaldehyde/Urea Molar Ratios

Ebewele, Robert O.; River, Bryan H.; Myers, George E. 1994. *J. Appl. Polymer Sci.* 52: 689–700.

The objective of this study was to investigate the effectiveness of modifying urea-formaldehyde resins with selected flexible amines at formaldehyde/urea ratios of 1.4 and 1.2. As in previous work, the effectiveness in terms of the resistance to cyclic soak-dry and moist-heat aging and in terms of the formaldehyde emission of bonded wood products was evaluated.

81. Improving Durability of Urea-Formaldehyde-Bonded Wood Joints

Ebewele, R.O.; River, Bryan H.; Myers, George E. 1993. *Adhesives Age*. 36(13): 23–30.

Results of this study support the hypothesis that the durability of urea-formaldehyde-bonded wood products is enhanced by incorporating flexible amine in the resin or by using hydrochloride amine salt curing agent, or both, which alters the adhesive structure and produces a more flexible cured network.

82. Phenolic Adhesive Bonds to Aspen Veneers Treated With Amino-Resin Fire Retardants

Vick, Charles B. 1994. *Forest Prod. J.* 44(1): 33–40.

The purpose of this study was to determine if a phenolic-based adhesive bonding system could produce strong and highly durable bonds in aspen veneers treated to 96 and 144 kg/m³ with urea, dicyandiamide, phosphoric acid, and formaldehyde (UDPF) fire retardant and to 106 and 154 kg/m³ with combined UDPF fire retardant and didecyldimethylammonium chloride preservative.

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